Hydrology and
Earth System
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Discussions

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comment

Interactive comment on "Reducing soil moisture measurement scale mismatch to improve surface energy flux estimation" *by* Joost Iwema et al.

Anonymous Referee #1

Received and published: 6 December 2016

OVERVIEW:

The presented manuscript investigates the potential impact of the measurement scale for calibration of a land surface model. For this purpose, observed and simulated land surface data at 12 sites on the continental US from several sources including Ameriflux, COSMOS and NLDAS was used. Point scale soil moisture data was compared to cosmic ray soil moisture retrievals. Furthermore, land surface simulations at the nine sites were done on an individual basis using JULES. At each sites, JULES was calibrated with cosmic ray data, point scale soil moisture data and eddy flux measurements. Model results were evaluated with eddy flux and soil moisture measurements. The case study demonstrates the added value of cosmic ray measurements at the model scale compared to local scale soil moisture measurements.

However, the study needs a major revision that addresses readability in the following: Reduce/clarify abbreviations, restructure part of the manuscript, improve English / sentence structure, remove speculations, be more specific /quantitative at a number of instances. There seems to be an issue with the data presented in Figure 7 concerning site MO.

The figures require further formatting. I suggest reducing the number of Figures. This allows the reader to focus on the essential messages of the study. I disagree with the outcome that coupling of soil moisture and latent heat flux is weak in JULES (e.g. see comment to Figure 9). Further suggestions in the Specific comments.

GENERAL COMMENTS:

The paper exhibits a clear novelty by quantifying the impact of using cosmic ray soil moisture data for calibration as compared to local point soil moisture measurements. The study fits the scope of the HESS journal and deserves to be published in HESS after major revision.

The conclusions reached in the manuscript are not clear enough. I also found different conclusions from the data and results presented. For details: See Specific comments to Chapter 4. The scientific methods and assumptions were well chosen and represent state of the art.

Description of experiments and calculations need to be revised. I suggest following new structure: Chapter 2.1 can remain there. Then, Chapter 2.3 should be changed to Chapter 2.2 as soil moisture data should be compared before calibration or modeling. Then explain JULES, then JULES forcing and initial conditions, the following Chapters can remain in place.

The results chapter needs a new structure. The results are presented in the right order but intermittent by discussions that are out of place because there IS a Chapter "3.8 Discussion". A more clear structure would be either consistently "3. Results and

Discussion" or "3. Results; 4. Discussion; 5. Conclusion". Please, stick to either one but do not mix.

The topic is complex and in general well addressed, but a new structure will increase readability and will make writing the paper more easy.

The title reflects the content. However, I would suggest a modification of the title to e.g. "Improved land surface processes by calibration with cosmic ray soil moisture measurements at the model scale".

The abstract is concise and summarizes the paper well. It may be modified if conclusions are changed.

In general, there is a large number of abbreviations (e.g. PS), symbols (in formulas), short names (e.g. smcrit). This makes the paper very difficult to follow. It is necessary to use either abbreviations, or symbols also in the text, ommit short names and in general write the names out more often. This paper almost needs a List of Abbreviations. Please, reduce them.

SPECIFIC COMMENTS:

Page 1 line...: 9: "sometimes" is too unprecise. Rephrase e.g. "can be calibrated" 10: EC, PS, LSM, CRNS, JULES - How can the abbreviations in the abstract be reduced? 12: Is there a term "soil-evapotranspiration"? I suggest "soil and evapotranspiration" or "soil-evaporation". 17: "CRNS calibrations" – What is actually meant is "LSM calibration" or something alike. 30: "atmospheric circulation" - In the UK? Be more specific here or do not mention it. 30: "Because", is "because" naturally a start of the sentence?

Page 2 line...: 1: "believed" - It is for THESE authors important or it is not. Maybe, why is it important. There is no "believe" in science. 4: "processes." Reference missing. 4: Remove "however". no added value. 14-15. Unclear, specify or rephrase. 22: "in-situ soil moisture" – I suggest to be consistent throughout the paper. in-situ or point scale is the same. So I suggest using one phrasing only. 24: soil moisture "IS" spatially...

and add reference e.g. Qu et al. 2015 in GRL. 26-28: "EC footprint average soil moisture" or "LSM grid cell" average soil moisture depends on the objective. As is, it is confusing. Rephrase to be clear. 31: Is this the research question? There is another research question on the next page. Either both should be allocated together or only one objective / research question is needed. As is, it is confusing.

Page 3 line...: 5 "usually assumed" - this is rather a fact due to soil heterogeneity. 10: One sentence paragraphs should be avoided. Also the use of "which" as often as it is used in the present manuscript, should be avoided. In English, short sentences are much better understood and much clearer. One sentence is preferably 1-2 lines only. 12: add the German CRNS network (Baatz et al 2015) 13: Repetition. 16: "similar" - be more specific. Similar is least informative and makes room for interpretation. 17: which – split the here sentence. 21: which - rephrase to "These sites" also look up the difference between which and that. Is the information you give with "which" really necessary? Then put it in one single sentence as it is worth a single sentence. 27: that – could that be removed here? 30: "Before our modelling exercise" ... This sentence should be moved up within the paragraph. First things first. 30-33: A shorter sentences are desirable.. It can be two or more sentences.

Page 4 line...: 10: "used data" - Specify "data". 10: remove brackets and specify e.g. "the upper first 30 cm". 15: Remove "Similar". 18: "CRNS integrated soil moisture" ... rephrase for better understanding e.g. soil moisture integrated over depth from CRNS soil moisture, hereafter referred to as CRNS soil moisture retrieval. 23: Split sentence, remove while. 31: remove which, split sentence 32: "More than 31 days were gap filled" using average diurnal pattern. This sounds like a really high uncertainty. Is this the case for precipitation, too? Is the high uncertainty reflected in the results? If so, where? Is it feasible to mark this in the Figures? Is it feasible to remove these periods from the calibration period? How much of modeled periods was filled with diurnal patterns?

Page 7 line...: 8: Rather "Calibration Approaches". Where is the "two-objective cali-

bration" in the methods section? 10-12: Sentence too long. Rephrase into at least two sentences. 12: Add reference (Shuttleworth et al . 2013) 14-15: This reads difficult. Either write saturated hydraulic conductivity instead of sathh or use the symbol introduced in Eq. 5. Same for all other symbols throughout the manuscript. 22-25: Shorter sentences. 27: This this.... rephrase

Page 12 line ...: 32: Remove "It should be noted however that".

Page 13 line...: 6: I suggest to put "and also containing stones" to the end of sentence or another place and remove brackets. 7: Here you write sathh out. Much better. However, the sentence may be moved to the discussion section. 13: I suggest to discuss these reasons. Actually, it is worth investigating each of the points to either accept them or rule them out. Mentioning all of these points / reasons is not getting the manuscript closer to the objective. 35: The "two-objective calibration" was not mentioned before. However, it is good to have it.

Page 14: line...: 5: comma before respectively. 7: was instead of "could have been" 7: "similar" - quantify or remove. 11: Suggestion: Move "to have obtained such automatic improvement" to the end of sentence 16: "improved soil moisture and latent heat flux". If calibration is done for both, both should be improved, no? 18: What does EF stand for? Too many abbreviations. Also WO...etc. There should be a way to distinguish places/sites from variables from acronyms. 19: "coincidence" – Not really, is it? 20: "Similar" - be precise. 21: "this" means what? context not totally clear. Rephrase. 27: "Generally quite weak" - Reference in literature? I cannot quite follow here. 28: What is the reasons that at these sites strong coupling is expected? At what time? Is the calibration done during the time of strong coupling? Very unclear how this conclusion is reached. I suggest an individual point of discussion. This is also the point where I cannot follow the conclusion drawn. It would be a major setback of JULES which needs to be justified much stronger. Above all, the results in the Figures show a meaningful difference in ET due to calibration / calibration method.

Page 15 line...: 4: "day time only" Why suddenly "day time only"? Is this throughout the manuscript the case or just here? LE measurements are difficult in the night. Diurnal cycles are difficult to obtain. Only modeled LE at times of observed ET should be compared, because there is no observations at other times. I do not see this here. 15: "Weak coupling..." Can the forcing data be the reason here? I disagree, see comments to Figure. 16: "CRNS-N/LE" - rephrase and make clear. 20-21: Suggestions: Split sentence into two. 28: "root zone soil moisture" is where exactly and calculated how? 32: split sentence at "while" and remove "while". Also at other instances in the manuscript, this makes sence.

Page 16 line ...: 4: Again the relatively weak coupling is discussed. Avoid repetition. Restructure. 5: "this suggests that how" - rephrase 9: Parameters should not move up or down after calibration. Variables and model states may be variable. "move closer" to what? 10: Which implications? Please name them and argue why. 14: "did not differ substantially". I disagree. They did differ. 17: "could be used"... you can put "should" instead. "we might have found worse fits". This is speculations. Please give reason or remove speculations. One could state: "You might have found better fits." 21: "Our findings support this." Your findings were that the JULES model is not an "improved land surface model", so the manuscript as is cannot support this. However, I see an impact of soil moisture states on latent heat flux in your model runs. Just have a look on Figure 11, how the RMSE in LE is reduced by calibration at sites DC,SO,KE,SR,WR. Only at few sites, RMSE in LE became higher. Soil moisture seemed to impact latent heat flux in JULES. The authors can be and should be more positive in the results, discussion and conclusion.

Table 1: -

Table 2: Add symbols from the equations and use symbols within the text.

Figure 1: I suggest removing the figure. The scale mismatch can be pointed out in a single sentence to save space for result figures e.g. The model grid cell size is 1km,

the EC footprint is between 100m2 to 1km2 (put here diameter instead), the CRNS footprint is 300m in diameter, the PS soil moisture sensor measures few dm3.

Figure 2: This Figure is very informative and necessary. Put Figure 2a and 2b instead of "upper".

Figure 3: Informative, you may want to keep it, however consider removing.

Figure 4: Here, MO looks like it has a big discrepancy / bias in PS to CRNS soil moisture. Why is this the case / is this in the manuscript? Put the legend (PS, CRNS)beside or below the figure, not in the first subplot. Minimum of Y axis is missing.

Figure 5: Informative. Keep it. CRNS observations are neutron flux. Soil moisture is retrieved from CRNS neutron flux observations. It should be rather something like CRNS soil moisture retrieval than CRNS soil moisture observation. Again, SM is abbreviated in your figure as SM, but not within the paper or at few instances. In general, abbreviations should be reduced.

Figure 6: What is the added value to Figure 5, because JULES is calibrated based on the data used in Figure 5. I suggest to merge Figures into one with e.g. Figure 5a and 5b.

Figure 7:Add grid lines. How can CRNS and PS soil moisture at MO be so different as in Figure 5, but Model results after calibration be so similar as in Figure 7. It seems very strange. Also you plot a 3 year time series with hourly values. It will be much easier to read, with more information and will have even more meaning if you average over days or months. So far, it is a lot of variability, which is clear beforehand if hourly values are plotted over the course of 3 years. You may consider merging Figure 7 and Figure 4.

Figure 8: The indices a) and b) are missing in the Figure. Axis labels at wrong place. Consider merging with Figure 10,11,12. The data may also fit into one table.

Figure 9: Interestingly WR and MO show a really strong change from Default to Cali-

brated. How do you get to the conclusion that there is no coupling of LE to soil moisture in JULES?

Figure 13: Labels and legend are overlapping.

Baatz, R., H. Bogena, H. J. Hendricks-Franssen, J. A. Huisman, W. Qu, C. Montzka, and H. Vereecken (2014), Calibration of a catchment scale cosmic-ray probe network: A comparison of three parameterization methods, J Hydrol.

Shuttleworth, J., R. Rosolem, M. Zreda, and T. Franz, 2013: The COsmic-ray Soil Moisture Interaction Code (COSMIC) for use in data assimilation. Hydrol Earth Syst Sc, 17, 3205-3217.

W. Qu, H. R. Bogena, J. A. Huisman, J. Vanderborght, M. Schuh, E. Priesack, H. Vereecken, Predicting subgrid variability of soil water content from basic soil information, Geophysical Research Letters, 2015, 42, 1-8.